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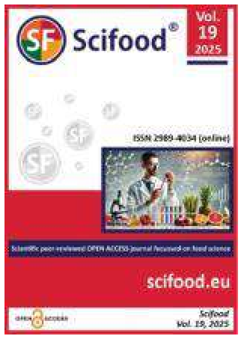

Effects of a probiotic complex on liver morphology in broiler chickens

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ABSTRACT

In industrial livestock farming, probiotic complexes of bifidobacteria and lactobacilli are used to improve the morphofunctional state of the domestic animals of the class Mammalia. In poultry farming, they are almost not used. That is why the study of the morphofunctional state of the broiler chicken organism, namely, the macro- and histoarchitectural morphology of their liver with the use of a probiotic complex of bifidobacteria and lactobacilli is an urgent issue. The absolute liver weight of the experimental broiler chickens, one-, 14-, and 42-day-old, when fed with complete feed and drinking water with the addition of a probiotic agent, did not essentially change in comparison with the indicators of the control broiler chickens. Still, a trend in its increase became visible. During ontogenetic development, the value of the absolute liver weight directly depends on the weight increase of the poultry organism during the experimental period. In pre-weaned chickens of 28 days of age, compared with the control group of birds of the same age, the absolute weight of the liver (32.3±1.07 g) was significantly ($p<0.05$) 1.15 times greater. With regard to the above-mentioned, the relative liver weight of the broiler chickens is the highest at the early stages of ontogenetic development, one-day-old (4.39±0.53%) and 14-day-old (4.25±0.27%) age. In comparison with the previous age groups of the chickens, the relative liver weight of the broiler chickens at 28 and 42 days of age is significantly reduced, equal to 2.27±0.12% and 1.72±0.08%, respectively, which indicates a progressive increase in their organ weight relative to the absolute liver weight. The relative liver weight in the experimental broiler chickens is similar in all age groups compared to the control ones. This confirms the positive effect of the probiotic complex of bifidobacteria and lactobacilli on the chicken organism of the experimental groups. The linear indicators and absolute weight of the liver, in the process of ontogenetic development in both control and experimental groups, are increased due to an expansion of the organ width relative to its length, as evidenced by a decrease in the liver development index in the age aspect: in the control group of one-day-old chicks, the IRP is 134.03±5.6%, in the 14-day-old chicks - 121.83±5.09%, in the 28-day-old chicks - 112.09±4.69%, in the 42-day-old chicks - 101.63±4.25%; in the broiler chicks of the experimental group, such indicators are lower - 138.96±5.81%, 116.78±4.88%, 107.44±4.49% and 98.95±4.14%, respectively.

Keywords: probiotic complex, bifidobacteria, lactobacilli, liver morphology, absolute weight, relative weight

INTRODUCTION

The main task of our country's agricultural sector is to produce agricultural products and to fully provide the population with safe and healthy foods.

However, under conditions of developed industry and introduction of modern innovative technologies of animal breeding and feeding into the production process of the livestock farming, the agricultural animals withstand significant overloads, and specific conditions of animal management, use of monotonous feed that has undergone technological processing, reduce the natural resistance level of the animal organism, which leads to various pathologies, reduction of productivity and efficiency of the industry as a whole **[1]**.

To resolve these problems, it is extremely important to have a full-value condition of the animal feeding ration, not only in terms of nutrients but also in terms of minerals. The deficiency of micro- and macronutrients in the animal organism leads to tissue metabolic disorders. It reduces the organism's natural resistance, which leads to the development of diseases, especially in new-born and young stock **[2]**, **[3]**, and [**4]**.

At present, various probiotic supplements that help protect the organism from infections, improve digestion, provide the organism with useful substances, etc., are used to strengthen and increase the resistance of human and animal organisms **[5]**.

Probiotics are living microorganisms (live microbial nutritional supplements) that help protect the organism from infections by killing harmful microorganisms and restoring the microbial balance of the intestine. They have a positive effect on human and animal health, improving digestion by normalizing the composition and function of the microbiota of the gastrointestinal tract **[6]**.

In veterinary medicine, probiotic complexes of bifidobacteria and lactobacilli can antagonize pathogenic and opportunistic microorganisms, maintain the balance of the intestinal microbiota, and provide overall health **[7]**.

Bifidobacteria make up 95% of the organism's microflora. They are responsible for properly functioning the digestive tract, strengthening the intestinal mucosa, and protecting the organism from harmful toxins. Bifidobacteria live mainly in the large intestine and can perform their function only with the support of lactobacilli **[8]**.

Lactobacilli make up 5% of the microflora. They are active in the oral cavity, respiratory system, small intestine, skin, and genital organs. Lactobacilli participate in the organism's immune defence, actively fight pathogens, secrete and metabolize lipids, and resist allergic reactions. They are much more active than bifidobacteria **[9]**.

In veterinary medicine, such drugs improve the morphofunctional state of the class Mammalia domestic animals. They are almost not used in poultry farming.

That is why studying the morphofunctional state of the poultry organism, namely, the morphology of the broiler chicken liver, using the probiotic complex of bifidobacteria and lactobacilli, is an urgent issue.

Scientific Hypothesis

Positive effect of probiotic complex of bifido- and lactobacteria on morphofunctional state of birds, namely macro- and histoarchitectonics of broiler chicken liver.

Objectives

Main objectives: to conduct morphological studies of the liver of clinically healthy broiler chickens at 1, 14, 28, and 42 days of age with the use of the probiotic complex of bifidobacteria and lactobacilli; to determine the liver development index of the broiler chickens of different age groups; to determine the absolute (ALW) and relative liver weight in dependence to the age group; to perform morphometry of the liver and its lobes.

MATERIAL AND METHODS

Samples

Samples description: The study object was the liver of cross-Cobb-500 broiler chickens of the control and experimental groups. To study the liver morphoarchitectonics under the influence of the probiotic complex of bifidobacteria and lactobacilli on the organism, the broiler chickens were slaughtered at 1, 14, 28 and 42 days of age, 10 birds each from the control and experimental groups.

Before slaughtering, the chickens were stunned with an electric current using the poultry stunning device Le Reve ("FAF", France).

Samples collection: For macroscopic studies and organometallic analysis, the samples (whole liver) were separated from the thoracic-abdominal cavity immediately after slaughtering the broiler chickens of the control and experimental groups (five chickens each) on the 1st, 14th, 28th, and 42nd days of the study.

Samples preparation: During the organometric analysis, the linear indicators and the absolute and relative weight of the liver and its macrostructures were determined. The following morphometric indicators were taken into account during the quantitative macroscopic study of the liver: liver height (LH); liver width (LW); absolute liver weight (ALW); relative liver weight (RLW); absolute weight of right lobe (AWRL); absolute weight of left lobe (AWLL); relative weight of right lobe (RWRL); relative weight of left lobe (RWLL); ratio of AWRL to ALW; ratio of AWLL to ALW; ratio of AWRL to AWLL.

The bioethical review committee approved the study protocol, which was authorised by the National University of Life and Environmental Sciences of Ukraine.

For macroscopic studies and organometric analysis, the liver was sampled, and its absolute and relative weight, length, and width were determined.

The absolute liver weight (ALW) and the absolute weight of its lobes were determined by their weighing. The relative liver weight (RLW) was calculated according to the following formula (1):

$$RLW = (ALW / BLW). 100 \%, \quad (1)$$

Where:

ALW is the absolute liver weight (g);

BW is the poultry body weight (g).

The linear indicators of the organ (length, width) were determined by a direct measuring method.

The liver development index (LDI) was determined by the ratio of their total length by their width according to the following formula (2):

$$LDI = (LH / LW) . 100 \quad (2)$$

Where:

- LH is the organ length (cm);
- LW is the organ width (cm).

Anatomical and histological terms for the structural parts of the lungs are given following the International Veterinary Histological Nomenclature (Terminology Dictionary) **[10]** and the International Veterinary Anatomical Nomenclature **[11]**.

Number of samples analyzed: 40 selected liver samples were examined during the experimental studies.

Chemicals

During the organometric analysis, no reagents were used, but the linear indicators were determined by using a ruler, as well as the absolute and relative weight of the liver and its macrostructures.

Animals, Plants and Biological Materials

All experimental studies were carried out in compliance with the requirements of the European Convention for the Protection of Vertebrate Animals used for Experimental or other Scientific Purposes of 1986, as well as the Law of Ukraine No. 3447-IV "On Protection of Animals from Cruelty" of 21.02.2006 as amended on 04.08.2017.

For the study, 100 heads of cross-Cobb-500 one-day-old broiler chickens were selected. According to the principle of analogues, one control group and one experimental group of 50 heads each were formed.

Instruments

The live weight of the broiler chicken body at 1, 14, 28 and 42 days of the study was monitored by weighing through the use of scales Aurora AU 309 (China) with a measurement accuracy of ± 1 g. The prepared liver's weight was determined through analytical scales AXIS (Poland) with a measurement accuracy of ± 0.001 g.

The liver measurements were performed as shown in Figures 1, 2 , 3 , 4, 5, 6, 7 and 8.

Laboratory

For macroscopic studies and organometric analysis, the liver was separated from the thoracic-abdominal cavity. During the organometric analysis, the linear indicators, as well as the absolute and relative weight of the liver and its macrostructures were determined **[12]**.

Description of the Experiment

Study flow: The experimental studies were conducted in compliance with the requirements of the European Convention for the Protection of Vertebrate Animals used for Experimental or other Scientific Purposes of 1986, as well as the Law of Ukraine No. 3447-IV "On Protection of Animals from Cruelty" of 21.02.2006 as amended on 04.08.2017.

For the study, two groups of cross-Cobb-500 one-day-old broiler chickens were formed according to the principle of analogue: one control and one experimental, 50 heads in each group (Table 1).

Table 1 Experimental samples of soybean oil**.**

Groups of broiler chickens	Number of poultry heads	Feeding
Control	50	Complete feed, drinking water, no probiotic agent added
Experimental	50	Complete feed, drinking water, with addition of probiotic agent “TIMM-P”

The broiler chickens were reared and kept on litter until 42 days of age. During the experiment, the broiler chickens were fed a basic ration, which provided the organism’s need for nutrients and biologically active substances. Access to drinking water was not restricted (giving to drink was carried out with the help of drinking Bowles).

The experimental broiler chickens were given the probiotic agent “TIMM-P” to drink for 2 hours in the morning before the first feeding in cycles: at 1-5, 21-25, and 30-35 days of the study. At the same time, the sanitary and hygienic indicators of the poultry management were controlled daily throughout the study period.

Quality Assurance

Number of repeated analyses: The study was repeated 5 times; the experimental data were processed by means of mathematical statistics.

Number of experiment replication: Each study was conducted five times with five samples, which resulted in 25 repeated analyses.

Reference materials: -

Calibration: Each instrument was calibrated before each experiment, and calibration checks were performed regularly to maintain measurement accuracy. Each instrument was calibrated before each experiment, and calibration checks were performed periodically to maintain measurement accuracy.

Laboratory accreditation:

Laboratory accreditation: The experiments were conducted based on the Ukrainian Laboratory of Quality and Safety of Agricultural Products, which is managed through the implementation of a management system built (since 2007) following the requirements of DSTU EN ISO/IEC 17025:2019 (EN ISO/IEC 17025:2017, IDT; ISO/IEC) 17025:2017, IDT) and confirmed by the Accreditation Certificate of the National Accreditation Agency of Ukraine.

Data Access

The data supporting the findings of this study are not publicly available.

Statistical Analysis

Statistical analysis was performed using the SPSS program (IBM SPSS Statistics 20). The methodology of analysis included one-factor analysis of variance (ANOVA). Comparisons were made at a significance level of $p < 0.05$. **[12]**.

RESULTS AND DISCUSSION

Morphological and morphometric study methods are of great importance in veterinary medicine. Such studies allow learning about the animal organism's structure and functions at multiple levels of its structural organisation, both under normal and pathological conditions **[13]**. Due to this, practicing veterinarians have an opportunity to find out and analyze the peculiarities of metabolic processes that occur in the animal organism at the cellular, tissue, and organ levels under the influence of one or another drugs that are currently used in the animal husbandry for animal productivity to be increased, etc.

Morphometric analysis of morphological structures, which has been used in morphology over the last few years, is characterised by objectivity and reliability and makes it possible to interpret scientific study results more logically **[14]**, **[15]**, and **[16]**.

That is why morphological (macroscopic, histological) and morphometric (organometric, histometric, cytometric) study methods, due to their reliable information content and scientific component, are mandatory to determine the influence of mineral elements, which are involved in metabolism, on the animal organism **[17]**, **[18]**, and **[19]** biologically active supplements (nutraceuticals) that have a positive influence on the organism and productivity of the broiler chickens **[20]**, and **[21]** probiotic additives **[22]**, **[23]**, and **[24]** which is one of the foundations for adequate nutrition of the animals to be provided, etc.

In this regard, we conducted morphological studies of the liver of clinically healthy broiler chickens using the probiotic complex of bifidobacteria and lactobacilli to determine the drug's effect and its mechanism of action on the experimental animal organism. It is related to the fact that the liver is one of the main multifunctional digestive organs, performing vital processes in the organism **[25]**, **[26]**. It promotes and takes an active part in carbohydrate metabolism **[27]**, and **[28]**, providing stability in glucose concentration in the blood, regulates the ratio of synthesis and breakdown of glycogen, and participates in all stages of lipid metabolism. Bile is synthesized in the liver **[29]**, and **[30]** the salts of which emulsify fats and increase the surface of their contact with lipase. As a multifunctional organ, the liver takes an active part in protein metabolism; it is the only organ in which such important proteins as prothrombin, fibrinogen, and proconvertin are synthesized, providing blood coagulation. Moreover, it performs many metabolic functions that are important for the life of an organism, participates in mineral and water metabolisms – absorbs excessive fluid, as well as influences the regulation of the content of mineral salts in blood and ratio of ions, regulates the activity of hormones, is a filter and source of energy for toxins, is an object for biomonitoring studies and carries out the hemostatic **[31]**, **[32]**, and **[33]**.

The work of cellular elements of its parenchyma—hepatocytes **[34]**, **[35]**, and **[36]—**provide the performance of numerous, diverse, and complex functions. Therefore, a detailed study of the structure of the liver as an organ and hepatocytes, in particular, under normal conditions, as well as changes in its morphoarchitecture that occur under the influence of one or another factor, does not cause doubts.

Concerning findings of our studies, the liver of cross-Cobb-500 one-day-old broiler chickens is brown (Fig. 1; 2). It is located in the thoracic-abdominal cavity in the ventrocaudal direction: from the third intercostal space to the end of the sternum. Ventrally, the liver borders on the sternum, and dorsocranially - on the heart, lungs, muscular part of the stomach and duodenum.

According to the morphological structure, the cranial and caudal notches at the respective liver edges divide the liver into the right and left lobes, between which the heart apex is located (Figure 1 and Figure 2).

The left lobe is much smaller in size and its absolute weight than the right lobe and has an intermediate process; it is divided into a larger lateral part and a smaller medial part by an intra-lobar notch (Fig. 1;2; table 3).

On the visceral surface of the liver there is a depression, that is the liver hilum, through which the hepatic arteries, portal veins and nerves enter the liver, and the hepatic duct and lymphatic vessels exit. The gallbladder is located on the visceral surface of the right lobe of the organ.

On the liver, the parietal and visceral surfaces, the cranial, caudal, and right and left lateral edges are differentiated (Figure 1 and Figure 2).

The parietal surface of the organ is adjacent to the ventral surface of the thoracic-abdominal cavity, so it is convex and smooth (Figure 1).

The liver's visceral surface is slightly concave and contacts the spleen, stomach, and duodenum, which form the corresponding depressions on the surface. The cranial edge of the liver of broiler chickens is blunt, and the caudal and lateral edges are sharp (Figure 2). There is an oesophageal indentation on the cranial edge and a caudal vena cava.

Figure 1 Macroscopic structure of the control chick's liver (parietal surface) at one day of age.

Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

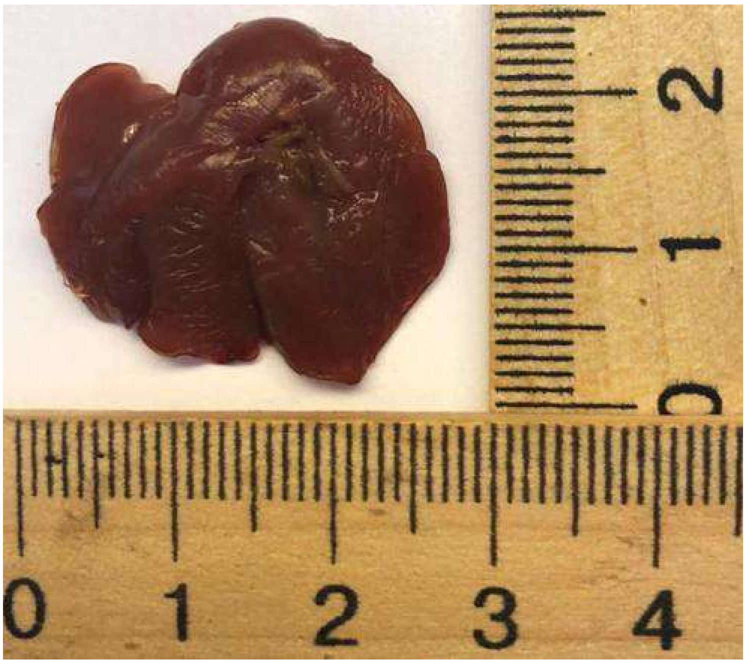

Figure 2 Macroscopic structure of the liver (visceral surface) of control chick at one day of age.

Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

Morphotopography and morphoarchitectonics of the liver of cross-Cobb-500 broiler chickens of the experimental group at 14, 28 and 42 days of age, in comparison with the control ones, had a similar anatomical structure as in the control group of the poultry, but differed in tissue density, colour change and organometric (length, width, absolute and relative weight of the liver as a whole and its structural components) indicators (Figures 1, 2, 3, 4, 5, 6, 7 and 8; Table 2 and Table 3).

Thus, the linear indicators of the liver of the broiler chickens at 14 days of age, both in the control and experimental poultry, increased in comparison with the liver of the same chickens at one day of age. The liver had a denser consistency (Figure 2 and Figure 3). The colour of the liver in the experimental group, compared with the control group, was yellow-brown (Figure 4).

In the poultry of the control and experimental groups at 28 days of age, the liver had a similar morpho-architectonics as in the poultry of the previous group. At the same time, the colour of its surface was heterogeneous - cherry colour with focal diffuse areas of light brown colour, especially in the control poultry (Figure 5 and Figure 6).

The linear indicators (length, width) of the liver of the broiler chickens at 42 days of age also increased in comparison with the previous groups of the poultry. The organ acquired the densest consistency, the surface of the liver was unevenly coloured - dark cherry with a brownish-matte tint (Figure 7 and Figure 8).

Figure 3 Macroscopic structure of the liver (parietal surface) of control chick at 14 days of age.
Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

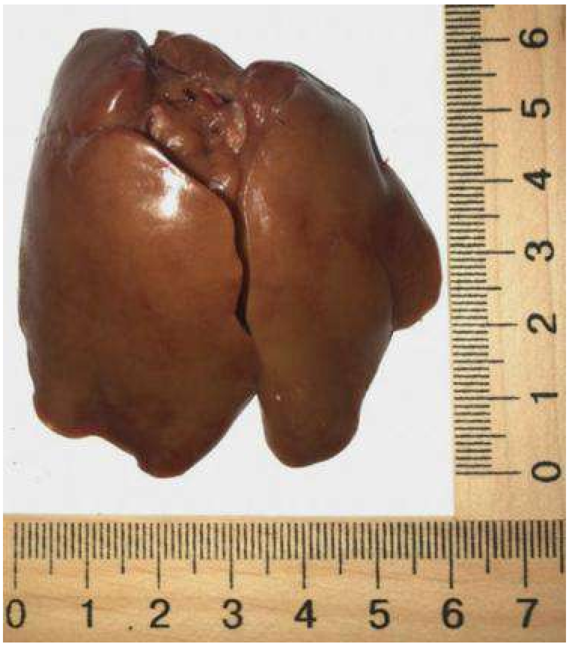

Figure 4 Macroscopic structure of the liver (parietal surface) of experimental chick at 14 days of age.
Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

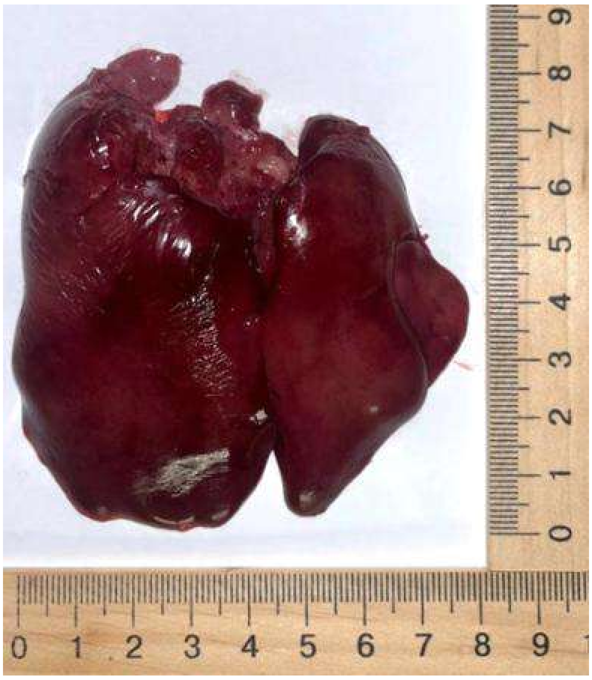

Figure 5 Macroscopic structure of the liver (parietal surface) of control chick at 28 days of age.
Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

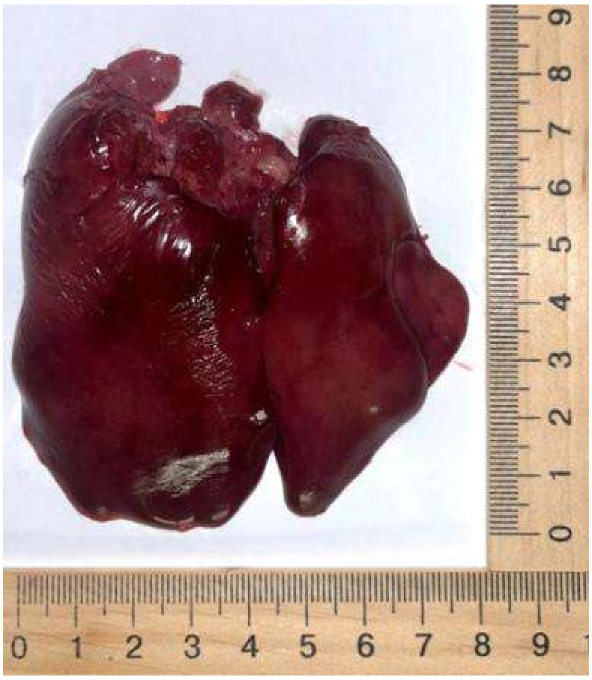

Figure 6 Macroscopic structure of the liver (parietal surface) of experimental chick at 28 days of age.
Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

Figure 7 Macroscopic structure of the liver (parietal surface) of control chick at 42 days of age.
Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

Figure 8 Macroscopic structure of the liver (parietal surface) of experimental chick at 42 days of age.
Note: a - right lobe; b - left lobe; c - lateral part of left lobe; d - medial part of left lobe; e - cranial notch; f - caudal notch. Gross specimen.

An important morphological criterion for the development and morphofunctional state of the animal organs and tissues is organometric studies, which make it possible to determine and establish quantitative characteristics of the animal organism in the process of ontogenetic and phylogenetic development under the influence of various environmental factors on the animal organism **[37]** with the use of (to increase the animal productivity) of biologically active and probiotic **[38]**, and **[39]**.

According to the results of the linear measurements of the liver, its indicators in the broiler chickens of the control and experimental groups, at one day of age, were similar and had the following values, respectively: the control chickens (length - 3.1±0.17 cm, width - 2.4±0.21 cm); the experimental chickens (length - 3.0±0.16 cm, width - 2.3±0.18 cm). Accordingly, the liver development index was 134.03±5.6 and 138.96±5.81 (Table 2).

In the control chickens at 14 days of age, in comparison with one-day-old chickens, the length and width of the liver significantly increased ($p<0.001$): length by 1.97 times, width by 2.16 times (Table 2). At the same time, the liver development index decreased and was equal to 121.83±5.09 %.

In the experimental poultry at 14 days of age, compared with the similar control ones, these liver indicators almost do not change, and an upward trend is only observed (Table 2). However, the liver development index in the experimental poultry has a downward trend and is 116.78±4.88 %, respectively, in the control poultry - 121.83±5.09 % (Table 2; Figure 9).

In the broiler chickens at 28 days of age, the following indicators (length, width) in the control and experimental groups increased in comparison with the chickens at 14 days of age: length in the control chickens by 1.07 times, width - by 1.13 times; in the experimental chickens, respectively, by 1.15 and 1.21 times.

Having compared the following indicators of the liver of the chickens at 28 days of age of the experimental and control groups, a significant increase ($p<0.05$) in the liver length by 1.15 times and, respectively, by 1.17 times in its width was found. At the same time, the liver development index of the experimental poultry at 28 days of age, in comparison with the control ones, had a downward trend and was 107.44±4.49 %, of the control poultry - 112.09±4.69 % (Table 2, Figure 9).

The liver is significantly increased in the chickens at 42 days of age. Its length and width significantly increased ($p<0.05$) in comparison with the previous age group of the control and experimental groups (Table 2). At the same time, these indicators of the liver of the experimental chickens at 42 days of age, compared with the control ones, remain almost the same. Accordingly, the liver development index of the corresponding age, in contrast with the previous age group of the chickens, decreased to 101 % in the control poultry and to 99 % in the experimental poultry (Table 2; Figure 9). It goes to show that the development of the liver and the growth of its linear indicators and absolute weight in the process of ontogenetic development in both the control and experimental groups occur due to an increase in the liver width relative to its length.

Table 2 Morphometry of linear measurements of broiler chicken liver of control and experimental groups.

Indicator	**Poultry age**							
	1 day		**14 days**		**28 days**		**42 days**	
	Control	**Exper.**	**Control**	**Exper.**	**Control**	**Exper.**	**Control**	**Exper.**
Liver length (cm)	3.1±0.17	3.0±0.16	6.1±0.3	6.5±0.34	6.5±0.3	7.5±0.37*	9.4±0.21	9.5±0.33
Liver width (cm)	2.4±0.21	2.3±0.18	5.3±0.41	5.8±0.48	6.0±0.41	7.0±0.29*	9.3±0.19	9.6±0.23
Liver development index (%)	134.03±5.6	138.96±5.81	121.83±5.09	116.78±4.88	112.09±4.69	107.44±4.49	101.63±4.25	98.95±4.14

Note: M±m; n=10, * - $p\leq0.05$; ** - $p\leq0.01$; *** - $p\leq0.001$ relative to the control group of the same group, Exper. - Experimental

The study of the absolute and relative weights of organs and systems is an important indicator of the morphofunctional state of the animal organism. It is of great importance in clinical and preventive medicine, etc. Such studies are reliable and used to assess the condition of internal organs under normal and experimental conditions.

The morphometry results show that the indicators of the absolute and relative weight of the animal organism organs are directly dependent on their age, species, breed, and significantly change with the development of pathological processes.

They are important indicators that reflect the degree of influence on the animal organism of pharmaceuticals, feed additives, etc. that are currently used in livestock farming, in particular poultry farming, to increase productivity **[40]**.

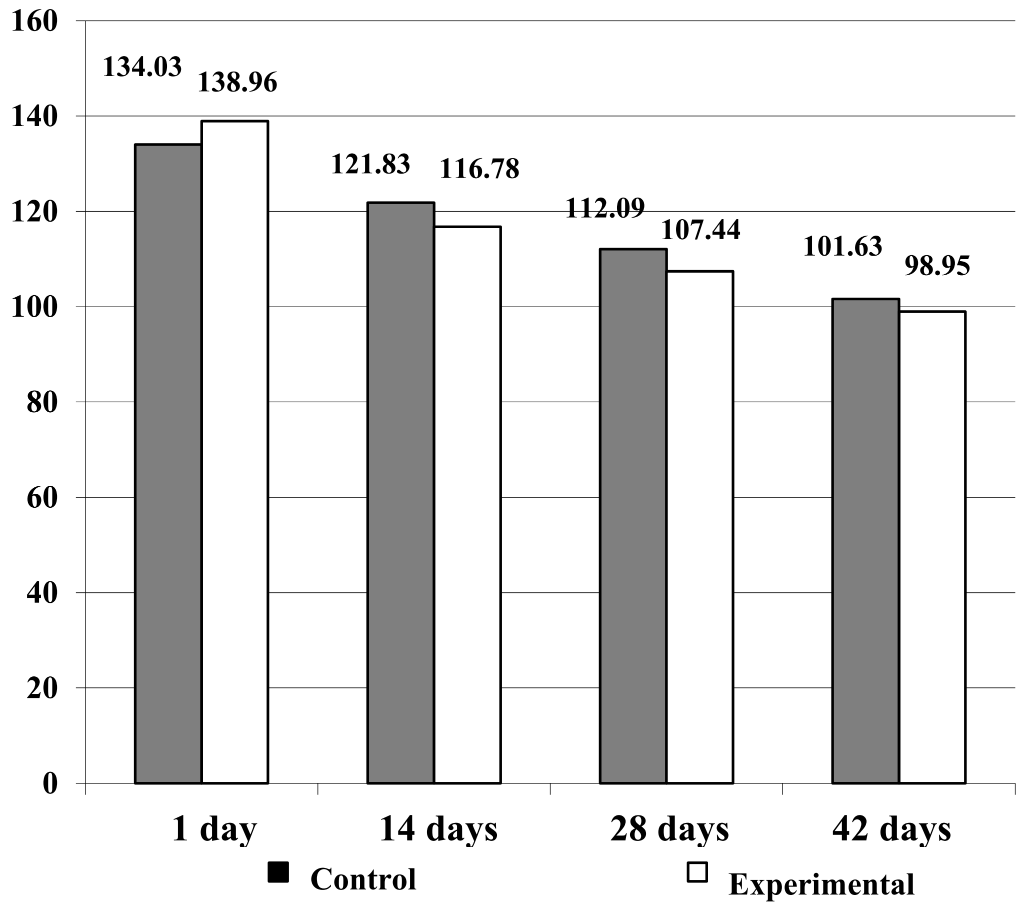

Figure 9 Liver development index of broiler chickens of control and experimental groups.

Regarding our studies' findings, the ALW of the control broiler chickens at one day of age was 2.2±0.14 g. This figure for the experimental broiler chickens at one day of age was similar and, accordingly, was 2.1±0.14 g (Table 3).

After 14 days, a significant increase ($p<0.001$) in ALW was observed in the broiler chickens of the control and experimental group, which were given the probiotic agent "TIMM-P" to drink, more than six times in comparison with the chickens at one-day of age. The absolute liver weight of the experimental chickens at 14 days of age, compared to the control ones, had only an upward trend (Table 3).

In the poultry at 28 days of age, compared with the poultry at 14 days, the absolute liver weight significantly increased ($p<0.001$) and amounted to 28.2±1.71 g in the control group. Accordingly, in the experimental poultry at 28 days of age, in comparison with the control poultry of the same age, this indicator was significantly ($p<0.05$) 1.15 times higher and was 32.3±1.07 g (Table 3).

In the poultry at the end of the experiment period at 42 days of age, in comparison with the poultry at 24 days of age, ALW also changed towards a significant increase ($p<0.001$): the control poultry - by 1.7 times, the experimental poultry - by 1.6 times (Table 3). At the same time, the absolute liver weight of the broiler chickens at 42 days of age, which were given the probiotic agent "TIMM-P" to drink, compared with the control ones, had only an upward trend (Table 3).

Table 3 Morphometry of absolute and relative liver weight and its components of broiler chickens of control and experimental groups.

Indicators		Poultry groups							
		1 day		14 days		28 days		42 days	
		Control	Exper.	Control	Exper.	Control	Exper.	Control	Exper.
Body weight, g		51.8±2.36	51.58±1.94	322.6±9.14	330.2±8.88	1240.4±34.18	1300.8±26.78	2916.5±115.89	2990.6±133.82
Absolute liver weight, g		2.2±0.14	2.1±0.14	13.6±0.39	14.2±0.65	28.2±1.71	32.3±1.07	49.6±2.16	52.7±1.35
Relative liver weight, %		4.39±0.53	4.07±0.17	4.25±0.27	4.35±0.34	2.27±0.12	2.48±0.1	1.72±0.08	1.79±0.1
AW of right lobe (g)		1.38±0.07	1.34±0.05	8.76±0.18	8.33±0.17	18.12±0.32	20.02±0.72	32.66±112	33.33±0.93
RW of right lobe (%)		64.16±3.72	66.09±5.06	65.5±2.54	60.45±4.42	66.06±4.01	62.91±3.45	66.61±2.71	63.64±2.47
AW of left lobe (g)	Total AW of left lobe	0.83±0.02	0.76±0.03	4.84±0.22	5.87±0.32	10.08±0.32	12.28±0.45	16.94±1.14	19.37±0.48
	AW of lateral part	0.68±0.02	0.63±0.03	3.98±0.19	4.79±0.13	8.16±0.08	9.92±0.37	12.88±0.94	14.66±0.34
	AW of medial part	0.15±0.01	0.13±0.008	0.86±0.09	1.08±0.22	1.92±0.36	2.36±0.17	4.06±0.53	4.71±0.45
RW of left lobe (%)	Total RW	35.84±3.72	33.91±5.06	36.03±3.48	39.55±4.42	34.32±3.85	37.09±3.45	33.39±3.2	36.36±2.47
	Lateral part	28.11±2.95	26.26±4.76	29.37±1.38	30.9±3.88	26.08±2.51	28.93±2.9	25.92±2.58	27.98±1.67
	Medial part	7.73±2.29	7.66±0.83	7.81±1.28	8.64±2.11	8.24±1.95	8.16±0.8	7.46±1.16	8.38±1.02
Ratio of AW of lateral part of left lobe to AW of its medial part		1:4.53	1:4.85	1:4.63	1:4.44	1:4.25	1:4.2	1:3.17	1:3.11
Ratio of AW of right lobe to ALW		1:0.63	1: 0.64	1:0.64	1:0.59	1:0.64	1:0.62	1:0.66	1:0.63
Ratio of AW of left lobe to ALW		1:0.38	1:0.36	1:0.36	1:0.41	1:0.36	1:0.38	1:0.34	1:0.37
Ratio of AW of right lobe to AW of left lobe		1:1.66	1:1.76	1:1.81	1:1.42	1:1.8	1:1.63	1:1.93	1:1.72

Note: M±m; n=10, * - p≤0.05; ** - p≤0.01; *** - p≤0.001 relative to the control group. Exper. – Experimental.

The relative weight of organs is directly proportional to the poultry body weight and the absolute weight of organs, the indicators of which change in the process of ontogenetic development, under experimental conditions, etc., so its value is directly related to the increase in the poultry body weight during the experiment period.

According to the morphometric analysis of our studies, the relative liver weight of the experimental broiler chickens at one day of age was 4.39±0.53 %. In the experimental group, this figure was almost the same as in the control group and, accordingly, was 4.07±0.17 % (Table 3).

The relative liver weight of the control and experimental broiler chickens at 14 days of age was similar to the previous age group and was 4.25±0.27 and 4.35±0.34 %, respectively. It shows a progressive symmetrical increase in ALW of the broiler chickens relative to the increase in the poultry body weight. At the same time, the relative liver weight of the control and experimental broiler chickens at 28 and 42 days of age significantly decreased compared with the previous age groups of the chickens. Thus, the relative liver weight of the control poultry at 28 days of age, in comparison with the chickens at 14 days of age, significantly decreased ($p<0.01$) by 1.9 times and was 2.27±0.12%, and of the experimental poultry (2.48±0.1%), respectively, by 1.75 times. The relative weight of the organ of the control broiler chickens at 42 days of age, in comparison with the chickens at 28 days of age, significantly decreased ($p<0.05$) by 1.32 times, respectively, and of the experimental chickens - by 1.38 times (Table 3). It shows a progressive increase in the poultry body weight relative to the value of ALW.

The relative weight of the organs of the experimental broiler chickens was similar to that of the control ones in all age groups, which indicates a positive effect of the probiotic complex of bifidobacteria and lactobacilli on the organism when the broiler chickens were fed complete feed and drinking water with the addition of a probiotic agent.

In analyzing the morphometry results of the liver of the experimental broiler chickens in general and their lobes (left, right) in particular, their absolute and relative characteristics, an increase in the absolute weight of the liver lobes was found in dependence to the age characteristics of the experimental poultry and the morphotopography of the liver (Table 3). At the same time, the largest AW in all age groups of the control and experimental poultry was observed in the right lobes, and much less in the left lobes (Table 3).

The relative weight of the liver lobes (right and left) of the broiler chickens relative to the average absolute weight of their liver is directly proportional to the poultry body weight and the absolute weight of the organ. In all age groups of the poultry, the relative weight of the right liver lobe relative to the total weight of the organ was the highest. It amounted to more than 60%, a much lower relative weight (up to 37%) was characteristic of the left lobes, which had similar values in all age groups. Such similar values of the relative weight of the liver lobes in all experimental broiler chicken groups are an indisputable evidence that in the process of ontogenetic development of the poultry, an increase in the absolute weight of the liver lobes correlates with a progressive increase in the absolute liver weight and the body weight of broiler chickens (Table 3).

With such digital absolute values of the liver lobes of the control and experimental poultry, the ratio of AW the right lobe to ALW in all age groups of the broiler chickens, in comparison with the ratio of AW of the left lobe to ALW, is higher, which indicates a progressive development of the right liver lobe relative to the left liver lobe, as evidenced by the results of the ratio of AW of the right liver lobe to AW of the left liver lobe, whose indicators have the highest values (Table 3).

At the same time, the organometric characteristics of the livers of the experimental broiler chickens were similar to those of the control ones; their difference was unreliable, which is direct evidence of the positive effect of the probiotic complex of bifidobacteria and lactobacilli on the broiler chicken organism under experimental conditions.

CONCLUSION

The absolute liver weight of the experimental broiler chickens, one-, 14-, and 42-day-old, when fed with complete feed and drinking water with the addition of a probiotic agent, did not significantly change, in comparison with the indicators of the control poultry, and an upward trend was only observed. In 28-day-old experimental chickens, compared to the control, liver AM (32.3±1.07 g) was significantly ($p<0.05$) 1.15 times greater. In ontogenetic development, one-day-old (4.39±0.53%) and 14-day-old (4.25±0.27%) age is the largest.

The relative liver weight of the experimental broiler chickens, compared with the control ones, was similar in all age groups, which indicates a positive effect of the probiotic complex of bifidobacteria and lactobacilli on the organism of the broiler chickens when fed complete feed and drinking water with the addition of a probiotic agent.

The linear parameters and the absolute liver weight in the process of ontogenetic development, both in the control and experimental groups, are increased due to an increase in the organ width relative to its length, as evidenced by a decrease in the liver development index in the age aspect. In one-day-old chicks of the control group, the IRP is 134.03±5.6%, in 14-day-old chicks - 121.83±5.09%, in 28-day-old chicks - 112.09±4.69%, in 42-day-old chicks - 101.63±4.25%. In broiler chicks of the experimental group, the IRP is lower, respectively 138.96±5.81%, 116.78±4.88%, 107.44±4.49%, and 98.95±4.14%.

The highest absolute liver weight in all age groups of the control and experimental poultry was observed in the right lobes and was significantly lower in the left lobes.

The relative weight of the liver lobes (right and left) of the broiler chickens relative to the average absolute weight of their liver is directly proportional to the body weight of the broiler chickens and the absolute weight of the organ: in all age groups of the poultry, the relative weight of the right liver lobe relative to the total organ weight is the largest (60% or more), while the left lobe is much smaller (up to 37%).

The ratio of the absolute weight of the right lobe to the absolute liver weight in all age groups of the poultry, in comparison with the ratio of the absolute weight of the left lobe to the absolute liver weight, is higher, which indicates a progressive development of the right lobe of the experimental broiler chickens. Such indicators of the experimental broiler chickens, in comparison with the control ones, are similar (their difference is unreliable), which is a direct evidence of the positive effect of the probiotic complex of bifidobacteria and lactobacilli on the broiler chicken organism under experimental conditions.

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All animal procedures were approved by the Bioethical Review Committee at the National University of Life and Environmental Sciences of Ukraine, in accordance with the Law of Ukraine No. 3447-IV and the European Convention (1986) on the Protection of Vertebrate Animals.

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